

ILIC, Ljubisa; MILUTINOVIC, Vladimir

Our experience with indications for changing or discontinuing
antitubercular agents. Tuberkuloza 15 no.2:238-244 Ap-Je '63.

1. Bolnica za grudobolne grada Beograda, Zemun, Bezanijska
Kosa - Upravnik: prim. dr Ljubisa Ilic.
(ANTITUBERCULAR AGENTS)

5

MILATINOVIC, VUKICA M.

10/10/64

✓ Section of iodine vapors during cathodic sputtering of
gold. Vladimir M. Vukanović and Vukica M. Milatnović.
Bull. Inst. Nuclear Sci. Beograd (1964).
The mention of I in a discharge tube for the cathodic sput-
tering of gold. The

1. Testing of the...
results indicate a preferential sorption of monar. over...
J. M. Blocher, Jr.

RUVIDIC, Rajko; BROZOVIC-VASIC, Milica; MILUTINOVIC-BRADIC, Leposava;
BROZOVIC, Branko

Determination of iron in the blood serum and bone marrow. Role
in the diagnosis and therapy of anemias. Vojnosanit. pregl. 19
no.4:280-288 Ap '62.

1. Medicinski fakultet u Beogradu, Interna klinika "B".
(IRON METABOLISM) (BLOOD CHEMICAL ANALYSIS)
(ANEMIA) (BONE MARROW)

MILUTINVIC, G.

"ew type of coordinated borer in the manufacture of DIXI
60 machine tools and new trends in the technique of
finishing machine parts. p. 1040. TEHNIKA (Savaz inzenjera
i tehnicara Jugoslavije) Beograd. Vol. 11, no. 7. 1956

SOURCE: East Europe Accession List (EEAL),
Library of Congress, Vol. 5, no. 11, Nov. 1956

MILVERE, J.

Equipment for pigpens.

P. 357, (Sotsialistlik Pollumajandus) Vol. 12, no. 8, Aug. 1957, Tallinn, Estonia

SO: Monthly Index of East European Accessions (EEAI) Vol. 6, No. 11 November 1957

MILVERE, J.

A barn must be of simple design and spacious.

p. 410 (Sotsialikstlik Põllumajandus) Vol. 12, no. 9, Sept. 1957, Tallin, Estonia

SC: MONTHLY INDEX OF EAST EUROPEAN ACCESSIONS (EEAI) LC, VOL. 7, NO. 1, JAN. 1958

MILVERE, J.

The exterior of buildings has to be kept in order. p. 327.

GAZ, WODA I TECHNIKA SANITARNA (Stowarzyszenie Naukowo-Techniczne
Inzynierow i Technikow Sanitarnych, Ogrzewnictwa i Gazownictwa)
Warszawa, Poland, Vol. 32, no. 6, June 1958.

Monthly list of East European Accession (EEAI) LW, Vol. 9, no. 2, Feb. 1960

Uncl.

L 7907-66 EWT(m)/T/EWP(t)/EWP(k)/EWP(b)/EWA(c) IJP(c) JD/HW
 ACC NR: AP5025776 SOURCE CODE: UR/0363/65/001/009/1449/1453

AUTHOR: Mil'vidskiy, M. G. ; Osvenskiy, V. B. ; Stolyarov, O. G.

ORG: Giredmet

TITLE: The effect of impurities on the plastic deformation of single crystals of silicon

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 1, no. 9, 1965, 1449-1453

TOPIC TAGS: silicon single crystal, plastic deformation, crystal impurity, activation energy

ABSTRACT: The investigations were made on single crystals of silicon without dislocations, grown by the Czochralski method. The pure single crystals had an impurity concentration of $5 \times 10^{14}/\text{cm}^3$; those alloyed with arsenic, $4 \times 10^{19}/\text{cm}^3$; and those with aluminum, $5 \times 10^{17}/\text{cm}^3$. The temperature dependence of the upper yield point of these crystals was investigated at a constant relative deformation velocity $v_0 = 6.5 \times 10^{-4}$ sec. An exponential relation of the following form was found:

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UDC: 546.28:548.55

L 7907-66

ACC NR: AP5025776

$$v_0 \approx B \sigma^n \exp\left(-\frac{U}{kT}\right),$$

where v_0 is the relative deformation velocity; B and n are constants; U is the activation energy of the process; k is the Boltzmann constant. The article gives a curve showing the dependence of the upper yield point of the crystals on the relative deformation velocity, at a constant temperature of 825 C. It follows from the experimental results that alloying with a donor impurity decreases the activation energy and somewhat increases the constant n, while an acceptor impurity has the opposite effect. The effect of donor and acceptor impurities on the plastic deformation of single crystals of silicon can be explained by the change in the equilibrium concentration of vacancies in alloying; this causes a p-type electron reaction within the semiconductors. Orig. art. has: 6 formulas, 2 figures, and 1 table

SUB CODE: SS, MM, IC/ SUBM DATE: 17Mar65/ ORIG REF: 003/ OTH REF: 018

nw

Card 2/2

MIL'VIDSKIV, M.G.; DELEVIN, G.V.

Methods of determining the coefficients of distribution of volatile impurities in growing gallium arsenide single crystals by oriented crystallization. Izv. AN SSSR. Neorg. mat. 1 no.9: 1454-1458 1965. (MIRA 18:11)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoj promyshlennosti, Moskva.

L 10858-66 EWT(1)/EWT(m)/T/EWP(t)/EWP(h)/EWA(c) IJP(c) JD/GG

ACC NR: AP5028712

SOURCE CODE: UR/0363/65/001/011/1858/1863

AUTHOR: ^{44,55} Mil'vidskiy, M. G.; ^{44,55} Berkova, A. V.; ^{44,55} Bol'sheva, Yu. N. 87
84

ORG: ^{44,55} Giredmet

TITLE: Method of developing inhomogeneities in silicon single crystals, ²⁷

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 1, no. 11, 1965, 1858-1863

TOPIC TAGS: crystal impurity, silicon single crystal, etched crystal, phosphorus, arsenic, antimony, boron, aluminum

ABSTRACT: The possibility of developing inhomogeneities in silicon single crystals was studied by selective anodic and chemical etching and by the electrodeposition of copper. ^{44,55} P, ^{44,55} As, ^{44,55} Sb, ^{44,55} B, and ^{44,55} Al were used as dopants. The optimum etching conditions were selected. The results are compared with data obtained from single-probe resistivity measurements. It is shown that anodic etching and copper electrodeposition are best suited for developing inhomogeneities in single crystals with resistivities above 1 ohm cm, and chemical etching is most appropriate in highly doped single crystals. In anodic etching and copper electrodeposition, areas rich in the impurity are most extensively etched. In chemical etching, the result depends on the type of conduction of the sample: in p-type crystals, areas rich in the impurity are etched

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UDC: 546.28:548.55

L 10858-66

ACC NR: AP5028712

most, whereas in n-type crystals, areas depleted of impurities are attacked. By choosing the most suitable method of etching, one can study the distribution of impurities in p- and n-type single crystals over a wide range of resistivities, from hundreds of ohm cm to 0.001 ohm cm. Orig. art. has: 6 figures, 1 table. 3

SUB CODE: 20,11/

SUBM DATE: 24Apr65/

ORIG REF: 006/

OTH REF: 009

Card 2/2

1 10851-66 EWT(1)/EWT(m)/T/EWP(t)/EWP(b)/EWA(c) IJP(c) JD/GG

ACC NR: AP5028713 SOURCE CODE: UR/0363/65/001/011/1864/1872

AUTHOR: ^{44,55} Mil'vidskiy, M. G.; ^{44,55} Grishina, S. P.; ^{44,55} Yermeyev, V. V.

ORG: ^{44,55} Giredmet

TITLE: Distribution of impurities in silicon single crystals in growing by the Czochralski method ^{21,44,55}

SOURCE: AN SSSR. Izvestiya. Neorganicheskiy materialy, v. 1, no. 11, 1965, 1864-1872

TOPIC TAGS: silicon single crystal, phosphorus, arsenic, antimony, aluminum, boron, single crystal growing, crystal impurity

ABSTRACT: The study was carried out on silicon single crystals doped with various concentrations of phosphorus, arsenic, antimony, aluminum, and boron and grown in the <111> direction by the Czochralski method. The distribution of impurities in various cross sections of the crystals was investigated by selective anodic and chemical etching, and the single-probe method of resistivity measurement was used for quantitative determinations. Several systems of growth bands were observed in the ingots, and possible causes of the formation of periodic inhomogeneities are examined. The effect of the nature and concentration of the doping impurity and the growth conditions on the manifestation of the "face effect" in single crystals is discussed.

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L 10857-66

ACC NR: AP5026713

The impurity substructures in crystals doped extensively with the various impurities were studied. Inclusions of the second phase during the growth of these crystals are probably due to a nonequilibrium trapping of droplets of melt rich in impurities. Orig. art. has: 6 figures.

SUB CODE: 20,11 SUBM DATE: 10May65/ ORIG REF: 017/ OTH REF: 006

HW

Card 2/2

L 10855-66 EWT(m)/T/EWP(t)/EWP(b)/EWA(c) IJP(c) JD/GG

ACC NR: AP5028719

SOURCE CODE: UR/0363/65/001/011/1898/1900

AUTHOR: ^{44, 55} Mil'vidskiy, M. G.; ^{44, 55} Osvenskiy, V. B.; ^{44, 55} Stolyarov, O. G.

ORG: ^{44, 55} Giredmet

TITLE: Study of the initial stage of deformation of gallium arsenide single crystals

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 1, no. 11, 1965, 1898-1900

TOPIC TAGS: ^{21, 44, 55} gallium arsenide, crystal deformation, yield stress, crystal dislocation, tellurium

ABSTRACT: A study was made of the behavior of n-type GaAs single crystals subjected to a uniaxial compression in the <111> direction at a constant rate, and the dependence of the "yield point jog" of the compression curves on the temperature and deformation rate was investigated. All the crystals were doped with tellurium to a carrier concentration of $6 \times 10^{16} \text{ cm}^{-3}$, and the deformation was carried out on a relaxometer in spectroscopically pure helium at 410-460°C. The temperature-time dependence of the upper yield point of GaAs was found to be in good agreement with the kinetic theory of dislocations. The activation energy of motion of dislocations U and the kinetic constant n for GaAs were determined. The value of U is approximately 1.6 ev, which is less than the corresponding values for silicon and germanium. It is concluded

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L 10855-66

ACC NR: AP5028719

ed that impurities affect the plastic properties of the crystals, particularly the
"yield point jog." Orig. art. has: 2 figures.

SUB CODE: 20.11/
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SUBM DATE: 22Feb65/

ORIG REF: 004/

OTH REF: 006

HW

Card 2/2

L 9575-66 EWT(1)/EWT(m)/ETC/EPF(n)-2/ENG(m)/T/ENP(t)/ENP(b) IJP(c) JD/AT
 ACC NR: APS027444 SOURCE CODE: UR/0181/65/007/011/3448/3450
 AUTHOR: ^{44, 55} Mil'vidskiy, M. G.; ^{44, 55} Osvenkiy, V. B.; ^{44, 55} Rashevskaya, Ya. P.; ^{44, 55} Yugova, T. G. ⁶⁹
 ORG: State Design and Planning Scientific Research Institute of the Rare Metals Industry, Moscow (Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut red-kometallicheskoj promyshlennosti)
 TITLE: Investigation of the ^{21, 44, 55} infrared absorption spectrum of n-type gallium arsenide
 SOURCE: Fizika tverdogo tela, v. 7, no. 11, 1965, 3448-3450 ²⁷ ²⁷
 TOPIC TAGS: gallium arsenide, IR spectrum, ^{21, 44, 55} semiconductor band structure
 ABSTRACT: GaAs is doped with tellurium to study the effect which this has on its infrared absorption and reflection and data are obtained on the band structure and effective mass of electrons. Curves are given for the coefficient of absorption as a function of wavelength at room temperature for specimens with various carrier concentrations. These curves show the following common characteristics: 1) a sharp increase in the coefficient of absorption with a reduction in wavelength between 0.9 and 1.5 μ ; 2) a smooth increase in absorption with wavelength above 4 μ ; 3) a plateau between 1.5 and 4 μ . Theoretical explanations are given for these effects. The Spitzer-Fan method was used to calculate the masses of electrons at the absolute minimum in the conduction band on the basis of the data obtained in this work. The re-

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L 9575-66

ACC NR: AP5027444

sults are tabulated. The effective mass increases with impurity concentration. Orig.
art. has: 2 figures, 2 tables, 1 formula.

SUB CODE: 20/

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ORIG REF: 001/

OTH REF: 007

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L 9660-66 EWT(1)/EWT(m)/T/EWP(t)/EWP(b)/EWA(c) LJP(c) JD/GG
ACC NR: AP5027447 SOURCE CODE: UR/0181/65/007/011/3454/3458

AUTHOR: Mil'vidskiy, M. G.; Osvenskiy, V. B.; Yugova, T. G. 4/9 B

ORG: State Design and Planning Scientific Research Institute of the Rare Metals Industry, Moscow (Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut red-kometallicheskey promyshlennosti) 44.55 44.55

TITLE: Decoration of dislocations in gallium arsenide crystals 70 27 27

SOURCE: Fizika tverdogo tela, v. 7, no. 11, 1965, 3454-3458

TOPIC TAGS: gallium arsenide, single crystal, crystal dislocation 21, 44, 55

ABSTRACT: A method is developed for decorating dislocations in GaAs single crystals. The specimens were n -GaAs single crystals grown by directional crystallization with a carrier concentration of 10^{16} - 10^{17} cm^{-3} , and a dislocation density of $\sim 10^4$ cm^{-2} . Copper was used as the decorating impurity. The copper was electrolytically plated on both surfaces of GaAs plates ~ 1 mm thick. The specimens were diffusion annealed in helium for 2.5-3 hours at 1000°C . Various cooling conditions were tried and the specimens were then observed under an infrared microscope. The results are tabulated. None of these methods of heat treatment seems to have any effect on the quality and distribution of dislocations in the specimen. The proposed method of saturation was found to be sufficient to produce supersaturated solid solutions in the crystals.

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L 9660-66

ACC NR: AP5027447

Copper is precipitated at dislocations only at temperatures of 800°C and higher. Therefore, the dislocations are decorated only when the specimen is held for a sufficient time in this temperature range during continuous cooling or isothermal holding. Photomicrographs of decorated dislocations are shown. The best results are produced by slow cooling to 800°C with subsequent quenching in water. Orig. art. has: 1 figure, 1 table.

SUB CODE: 20/

SUBM DATE: 14Jun65/

ORIG REF: 000/

OTH REF: 006

Card 2/2

MIL'VIDSKIY, M.G.; OSVENSKIY, V.B.; STOLIYAROV, O.G.; SHLYAKOVA, D.B.

Dependence of the microhardness of single crystals of silicon on the density of dislocations and the concentration of impurities. Fiz. met. i metalloved. 20 no.1:150-151 Ji '65. (MIRA 18:11)

1. Nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoj promyshlennosti, Moskva.

BERKOVA, A.V.; MIL'VIDSKIY, M.G.; OSVENSKIY, V.B.

Exposure of inhomogeneities in the distribution of impurities in
gallium arsenide crystals. Zav. lab. 31 no.9:1095-1096 '65.

(MIRA 18:10)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut
redkometallicheskoj promyshlennosti.

L 26455-66 EWT(1)/EWT(m)/T/EWP(t) IJP(c) GO/ID

ACC NR: AP6017367

SOURCE CODE: UR/0363/66/002/003/0409/0412

AUTHOR: Pelevin, O. V.; Voronkov, V. V.; Mil'vidskiy, M. G.; Belyayev, A. I.

37
B

ORG: Giredmet

TITLE: Distribution of volatile impurities in growing crystals by oriented crystallization

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 2, no. 3, 1966, 409-412

TOPIC TAGS: crystal growing, semiconducting material, crystallization, single crystal, impurity level

ABSTRACT: Inasmuch as alloying of crystals of decomposed semiconductor compounds are usually conducted with volatile impurities, and many impurities form stable compounds with one of the basic components, it was of interest to examine the distribution of volatile impurities in crystals grown by oriented crystallization in the presence of the condensed phase of such a compound. The conditions necessary for obtaining alloyed single crystals with equal distribution of the impurity are analyzed. Orig. art. has: 14 formulas. [JPRS]

SUB CODE: 20 / SUBM DATE: 19Aug65 / OTH REF: 001

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PB

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L 32044-66 EWT(m)/EWP(w)/T/EWP(t)/ETI IJP(c) JD

ACC NR: AP6013336

SOURCE CODE: UR/0363/66/002/004/0585/0588

AUTHOR: Mil'vidskiy, M.G.; Osvenskiy, V.B.; Stolyarov, O.G.

ORG: Giredmet

TITLE: Effect of doping on the creep of single-crystal silicon

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 2, no. 4, 1966, 585-588

TOPIC TAGS: silicon single crystal, creep

ABSTRACT: The creep of single-crystal silicon was studied on dislocation-free and doped samples grown by Czochralski's method. The initial period of creep corresponding to the diffusional displacement of the dislocation nucleus is adequately described by a cubic parabola in both types of samples. Moreover, an exponential dependence of the initial period of creep and rate of steady creep on the magnitude of the applied stress is observed. The creep of single-crystal silicon doped with a donor impurity is higher, and that of silicon doped with an acceptor impurity is lower than the creep of pure single-crystal silicon. When pure and doped samples of single-crystal silicon are loaded a second time, their creep increases. A decrease of the initial period of creep and increase of the rate of steady creep are observed. The authors thank V.V. Khongulov for

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UDC: 546.48

L 32044-66

ACC NR: AP6013336

assistance in the work. Orig. art. has: 4 fig., 1 table, and 3 formulas.

SUB CODE: 11, 20 / SUBM DATE: 14Sep65 / ORIG REF: 005 / OTH REF: 013

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L 32052-66 EWT(1)/EWT(m)/T/EWP(t)/ETI IJP(c) JD/JG/AT

ACC NR: AP6013342

SOURCE CODE: UR/0363/66/002/004/0636/0642

AUTHOR: Vekilov, Yu. Kh.; Mil'vidskiy, M.G.; Osvenskij, V.B.; Stolyarov, O.G.; Kholodnyy, L.P. 51
B

ORG: Giredmet

TITLE: Effect of doping and illumination on the microhardness of semiconductor single crystals 2

SOURCE: AN SSR. Izvestiya. Neorganicheskiye materialy, v. 2, no. 4, 1966, 636-642

TOPIC TAGS: gallium arsenide, hardness, semiconductor single crystal

ABSTRACT: The microhardness of n- and p-type GaAs single crystals was studied as a function of the carrier concentration, illumination with white light, crystallographic orientation, and magnitude of the load on the indenter. It was shown that doping of GaAs with a donor or acceptor impurity causes a decrease in microhardness, as in the case of Si and Ge. It was established that both the concentration effect and the illumination effect in the semiconductor single crystals studied are surface effects and are observed to a depth of a few microns. The results are explained by the peculiar properties of the surface of semiconductors and are attributed to the presence in the transition layer of Card 1/2 21 11 18

UDC: 537.311.3

L 32052-66

ACC NR: AP6013342

an electric field perpendicular to the surface. It was established that the length of the prongs of dislocation "rosettes" formed around the imprints increases when donor and acceptor admixtures are used in doping, this being in accord with the concentration effect of decrease in microhardness. Although the explanation of the observed effects is not always unambiguous (because of the complexity of the phenomena), the method of microhardness measurement may be used to study the surface properties of semiconductors. Orig. art. has: 6 figures and 1 table.

SUB CODE: 11, 20 / SUBM DATE: 27Jul65 / ORIG REF: 010 / OTH REF: 003

Card 2/2

L 29796-66 EWT(m)/T/EWP(t)/ETI IJP(c) JD
 ACC NR: AP6015065 (N) SOURCE CODE: UR/0363/66/002/005/0833/0837

AUTHOR: Karatayev, V. V.; Mil'vidskiy, M. G.; Zakharova, N. Ya.

ORG: Giredmet

TITLE: Density and surface tension of fused gallium arsenide

SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 2, no. 5, 1966, 833-837

TOPIC TAGS: gallium arsenide, surface tension, arsenic, vapor pressure

ABSTRACT: The density of gallium arsenide at the melting point and at an equilibrium vapor pressure of arsenic was determined pycnometrically in a sealed quartz ampoule. The initial gallium arsenide had an n-type conductivity and a carrier concentration of 10^{16} - 10^{17} cm⁻³. The density was found to be 5.99 ± 0.08 g/cm³. The volume change on melting was 11.3%. The surface tension, also measured in a sealed quartz ampoule at definite arsenic vapor pressures, determined by weighing falling drops, was found to be 442 ± 16 dynes/cm for a melt of stoichiometric composition. A relationship was established between the surface tension of fused gallium arsenide and the vapor pressure of arsenic in the ampoule. Tellurium and excess arsenic were

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L 29796-66

ACC NR: AP6015065

shown to be surface-active impurities in gallium arsenide. Orig. art. has: 3 figures, 3 tables, and 3 formulas.

SUB CODE: 20,07/ SUBM DATE: 17Sep65/ ORIG REF: 007/ OTH REF: 007

Card 2/2 *N*

L 45958-66 EWT(m)/T/EWP(t)/ETI IJP(c) JD

ACC NR: AP6015477

SOURCE CODE: UR/0181/66/008/005/1539/1544

AUTHOR: Sazhin, N. P.; Mill'vidskiy, M. G.; Osvenskiy, V. B.; Stolyarov, O. G.

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49
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ORG: State Scientific-Research and Design Institute of the Rare Metals Industry, Moscow
(Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoj promyshlennosti)

TITLE: The influence of alloying on the plastic deformation of gallium arsenide single crystals

27 27 19

SOURCE: Fizika tverdogo tela, v. 8, no. 5, 1966, 1539-1544

TOPIC TAGS: acceptor, plastic deformation, alloying, gallium arsenide crystal, electron donor, single crystal structure, crystal dislocation

ABSTRACT: The authors investigate the influence of alloying by donor and acceptor admixtures on the behavior of GaAs during plastic deformation. The single crystals were obtained by the method of oriented crystallization and had the properties indicated in Table 1. An analysis of the results obtained shows that it is necessary to take into consideration several factors. These include the elastic and the electrical interaction of the dislocations with the admixtures, the possible structure of dislocations which determine their mobility, the interaction of the dislocations with the vacancies, and the influence of the admixtures on the equilibrium concentration

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ACC NR: AP6015477

Table 1
Properties of GaAs Crystals

Type of Conductivity	Alloying Admixture	Concentration of Current Carriers, cm^{-3}
n	—	$6.0 \cdot 10^{16}$
n	Te	$1.7 \cdot 10^{17}$
n	Te	$7.0 \cdot 10^{17}$
n	Te	$1.6 \cdot 10^{18}$
n	Te	$8.8 \cdot 10^{18}$
p	Zn	$1.0 \cdot 10^{18}$
p	Zn	$1.2 \cdot 10^{18}$

of charged vacancies. The last two factors, apparently, play the determining role in the determination of the influence of the donor and the acceptor admixtures on the mechanical properties of elementary semiconductors. However, in the case of semiconductive compounds the influence of the concentration of vacancies on the motion of dislocations is not determining, whereas the mobility of dislocations is primarily determined by their structure and interaction with the admixtures. The authors express their gratitude to V. I. Nikitenko for discussing the results and for his comments. Orig. art. has: 3 figures, 2 formulas, and 2 tables.

SUB CODE: 20/ SUBM DATE: 05Jul65/ ORIG REF: 007/ OTH REF: 013

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L 95630-67 FWT(E)/EWF(W)/T/TWP(T)/ETL LJE(E) JD

ACC NR: AP6024503

SOURCE CODE: UR/0181/66/008/007/2253/2255.

AUTHOR: Fomin, V. G.; Mil'vidskiy, M. G.; Solov'yeva, Ye. V.

ORG: State Scientific Research and Design Institute of the Rare-Metal Industry, Moscow (Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoj promyshlennosti)

TITLE: Influence of structure defects on certain electric properties of germanium doped with gold and antimony

SOURCE: Fizika tverdogo tela, v. 8, no. 7, 1966, 2253-2255

TOPIC TAGS: germanium semiconductor, semiconductor impurity, impurity level, hole mobility, crystal dislocation, crystal defect, Hall effect, electric conductivity

ABSTRACT: The purpose of the investigation was to explain the anomalous decrease in the mobility of the majority carriers at low temperatures, observed in strongly doped single-crystal p-type germanium. To this end, tests were made on single crystals grown by the Czochralski method in the [111] direction and cut into plates perpendicular to the growth axis. The dislocation density in the investigated samples ranged from 1×10^3 to $5 \times 10^4 \text{ cm}^{-2}$. Microscopic x-ray diffraction studies have disclosed the presence of an appreciable number of point defects in addition to dislocations. The degree of inhomogeneity of the crystals was determined by microphotometry of the x-ray diffraction patterns. Measurement of the electric conductivity and of the Hall effect at room temperature showed no oscillations in the properties of the

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ACC NR: AP6024503

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samples, thus indicating relatively uniform distribution of the gold atoms in the solid solution. Measurements at 77K have shown, however, that some plates were strongly inhomogeneous. The observed disturbances of the crystal lattice are attributed either to finely dispersed segregation of eutectic gold-germanium segregations, or to the presence of pre-precipitation regions. The maximum inhomogeneity of the distribution of the electric properties took place in the samples with maximum structural inhomogeneity, as manifest by variations of the density of the x-ray diffraction patterns. It is in these samples that the minimal values of the carrier mobility were observed. The most probable cause of the decrease in the mobility at low temperatures is thus attributed to the inhomogeneous distribution of the gold or antimony and of other uncontrolled impurities with shallow levels. The latter can be due either to primary processes during crystallization or to precipitation occurring during the cooling of the crystal. The authors thank A. M. Yelistratov, R. A. Zvinchuk, M. I. Iglitsyn, V. I. Fistul, and V. P. Aver'yanova for interest and for a discussion of the experimental results. Orig. art. has: 2 figures and 1 formula.

SUB CODE: 20/ SUBM DATE: 15Nov65/ ORIG REF: 004/ OTH REF: 004

Card 2/2 *eq/p*

L 06120-67 EWT(1)/EWP(t)/ETI IJP(c) JD/GG
 ACC NR: AP6030763 (A) SOURCE CODE: UR/0363/66/002/009/1549/1553
 AUTHOR: Grishina, S. P.; Mil'vidskiy, M. G.; Osvenskiy, V. B. 33
 ORG: Giredmet 18
 TITLE: Procedure for detecting dislocations by etching single crystals of gallium ar-
senide 15 27
 SOURCE: AN SSSR. Izvestiya. Neorganicheskiye materialy, v. 2, no. 9, 1966, 1549-1553
 TOPIC TAGS: gallium arsenide, etched crystal, metal etching
 ABSTRACT: Richards-Crocker etchant was used to detect characteristic etch pits on the
 (111) surface of gallium arsenide by successive applications. These experiments and
 experiments on the plastic deformation of crystals demonstrate that the etch pits cor-
 respond to the outcrop sites of the dislocations. On the (110) plane, this etchant
 leads to polishing and not to selective etching. An etchant consisting of $\text{HF:HNO}_3:\text{H}_2\text{O}$
 $=1:7:12+1\cdot 10^{-2}$ molar solution of AgNO_3 was used for selective etching as well as for
 the detection of dislocations. Orig. art. has: 6 figures, 2 formulas.
 SUB CODE: 20 11 / SUBM DATE: 07Dec65/ ORIG REF: 001/ OTH REF: 007
 UDC: 546.681'191 : 548.55 : 551.243

Card 1/1 *plw*

L 06592-67 EWT(m)/EWP(t)/ETI IJP(c) JD/WW/JW/JG
ACC NR: AP6029854 (A,N) SOURCE CODE: UR/0032/66/032/008/0968/0970

AUTHOR: Pelevin, O. V.; Mil'vidskiy, M. G.; Belyayev, A. I.; Khotin, B. A.;
Shulepnikov, M. N.; Voronkov, V. V.

63
13

ORG: State Scientific Research and Planning Institute of the Rare Metal Industry
(Gosudarstvennyy nauchno-issledovatel'skiy i proektniy institut redkometallicheskoj promyshlennosti)

TITLE: Determination of the vapor pressure of volatile substances

SOURCE: Zavodskaya laboratoriya. v. 32, no. 8, 1966, 968-970

TOPIC TAGS: vapor pressure, selenium, radioactive isotope, temperature dependence, diatomic molecule, thermodynamic analysis

ABSTRACT: A static method was developed for determining the vapor pressure from the radioactivity of the vapor, based on a proportional dependence of radioactivity to the quantity of material in the measured volume. In the proposed technique only the molecular composition of the vapor need be known. A schematic diagram of the experimental apparatus shows 13 components. The saturated vapor pressure of selenium was determined at temperatures ranging from 380 to 580°C. Quartz ampoules with weighed portions of Se^{75} were evacuated to a pressure of $1-3 \cdot 10^{-6}$ mm Hg and placed in the apparatus. Calibration curves were obtained by a series of experiments using different weights. Log

UDC: 541.12.034.6

Card 1/2

L 06592-67

ACC NR: AP6029854

P_{Se} is given as a function of temperature, P_{Se} being determined by measuring the counting rate for different condensate and/or vapor temperatures during heating and cooling. In the presence of a condensate, the counting rate depended exponentially on the condensate temperature, while after full vaporization, the counting rate was directly proportional to the average absolute temperature of the vapor phase. Thermodynamic equations were given for the dissociation process $Se_6 \rightleftharpoons 3Se_2$ and the free energy was related to the Se_2 concentration, the vapor pressure, and the cross section area and length of the ampoule. By extrapolating the rate constant for saturated selenium vapors to 933°K, the minimum temperature of the lower zone of the calibration curve, P_{Se_2} was calculated to be 95% P . For unsaturated vapors a new equilibrium condition was established with even greater quantities of diatomic molecules. The heat of vaporization of selenium was calculated to be 25.6 Kcal/mol. The above method may be used for determining the molecular composition of vapors. Orig. art. has: 2 figures, 2 formulas.

SUB CODE: 20,18/ SUBM DATE: none/ ORIG REF: 001/ OTH REF: 004

Card 2/2 LS

ACC NR: AP7009052 (A, N) SOURCE CODE: UR/0413/67/000/003/0018/0018

INVENTOR: Abayev, B. I.; Mil'vidskiy, M. G.; Yeremeyev, V. V.; Mityukhin, N. F.;
Petrov, Yu. A.; Ofitsaerov, K. D.

ORG: None

TITLE: A device for growing single crystals. Class 12, No. 190864

SOURCE: Izobreteniya, promyshlennyye obraztsy, tovarnyye znaki, no. 3, 1967, 18

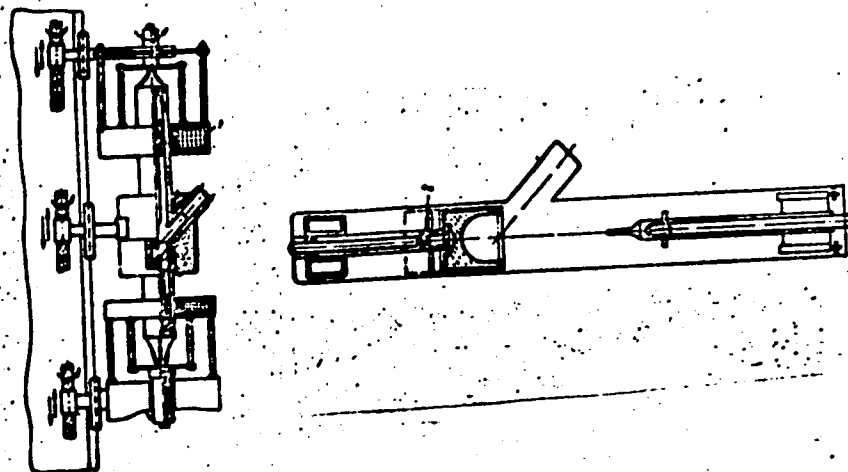
TOPIC TAGS: single crystal growing, quartz, electromagnet

ABSTRACT: This Author's Certificate introduces a device for growing single crystals of decomposable compounds by pulling from a melt in a crucible. The unit contains a quartz chamber of uniform diameter with inspection window and a hollow quartz rod for rotating and moving the seed. To rotate the crucible at a controllable rate and to control the rate of rotation and motion of the seed, the unit is equipped with stationary electromagnets consisting of water-cooled copper tubes and rotatable pole pieces. A quartz needle bearing is used for smooth rotation of the crucible containing the melt.

UDC: 542.65:548.55

Card 1/2

ACC NR: AP7009052



1--stationary electromagnet; 2--self-adjusting needle bearing

SUB CODE: 20/ SUBM DATE: 19Apr65

Card 2/2

9.4300(1035,1138,1143)

AUTHORS:

Mil'vidskiy, M.G., Layner, L.V. and
Ovsyannikova, S.P.

S/070/60/005/005/015/017
E132/E360

84126

TITLE:

Dendritic Structure in Single Crystals of Silicon
Grown from the Melt by Czochralski's Method

PERIODICAL:

Kristallografiya, 1960, Vol. 5, No. 5,
pp. 817 - 818

TEXT: A dendritic structure was found in a number of specimens of single crystals of silicon, oriented to show the 111 plane and etched in a mixture of HF , HNO_3 and $(\text{CH}_3\text{CO})_2\text{O}$ in the ratio of 1:3:3. The origin of this structure appears to be crystallisation at a temperature below the temperature at which certain impurities separate out from the melt. Here, dendritic growth is most frequent when crystals are pulled out of technical silicon (purity 99.7 - 99.8%). Dendrites are developed in the 111 planes and when a section across them is cut in the 111 plane a picture is obtained which is very like that found in the octahedral slipping in crystal of Ge and Si when dislocations are developed. In purer materials dendrite formation is connected

Card 1/2

84126

S/070/60/005/005/015/017
E132/E360

Dendritic Structure in Single Crystals of Silicon Grown from the Melt by Czochralski's Method

with the presence of impurities (Ta, Ti, Fe, Mo) with solubilities within the limits 10^{-3} to 10^{-4} %. Ingots grown from supercooled melts also show this dendritic structure. It is most readily shown on surfaces which have suffered light oxidation as a result of etching. The growth of dendrites on slow cooling of a melt in a vacuum has been observed (on the free surface of the melt). The purer the Si the greater the supercooling at which dendritic growth begins and the slower the growth is. There are 3 figures and 3 references: 2 Soviet and 1 English.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoy promyshlennosti (State Scientific Research and Design Institute for the Rare Metal Industry)

SUBMITTED: April 4, 1960

Card 2/2

31029

S/032/60/026/06/18/044
B010/B016

24.7500

AUTHORS:

Mil'vidskiy, M. G., Berkova, A. V.

TITLE:

Mordants for Making Visible Dislocations in Silicon Single Crystals

PERIODICAL: Zavodskaya laboratoriya, 1960, Vol. 26, No. 6, pp. 728-729

TEXT: The authors state that in mordants containing hydrofluoric acid, acetic acid, and nitric acid, the latter may cause under certain circumstances an oxidation of the surface of the sample (silicon single crystals). This is thought to be due to the excess of water. To prevent the surface oxidation, some compositions of mordants were studied (Table), in which connection glacial acetic acid was added to bind the excess water. The most satisfactory results were obtained with the following mordants: $\text{HF} : \text{HNO}_3 (55\%) : (\text{CH}_3\text{CO})_2\text{O} = 1 : 3 : 3$. The addition of glacial acetic acid stabilizes the corrosive process, i.e. it takes place independently of variations of the nitric acid concentration. The last-mentioned mordant was tested on samples of p- and n-silicon and it

Card 1/2

Mordants for Making Visible Dislocations in
Silicon Single Crystals

S/032/60/026/06/18/044
B010/B016

was found that p-n transitions, the unequal distribution of impurities
etc. may be made visible. There are 1 figure and 1 table.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy
institut redkometallicheskey promyshlennosti (State
Scientific Research and Planning Institute of Rare Metal
Industries)

Card 2/2

RUSSIAN SKI, M G

FRANK I BOOK EXPLANATION 807/554

Tumashov, N. D., Doctor of Chemical Sciences, Professor, ed.
Kazantsev, I. I. (ed.) *Metallurgical Corrosion: Abstracts of
studies (Corrosion and Protection of Construction Metals). Collection of
Articles* Moscow, Mashin, 1961. 256 p. Errors ally inserted. 10,000
copies printed.

MA. of Publishing House: N.P. Yevstaf'yev; Tech. Ed.: G.V. Smirnov;
Managing Ed. for literature on Chemical and Textile Machine Building:
V.I. Ryabova, Engineer.

REMARKS: This collection of articles is intended for scientific and technical
personnel concerned with the corrosion and protection of metals.

CONTENTS: The collection deals with problems of the corrosion of constructional
metals in various environments and conditions. Articles discuss new methods
for the investigation and testing of corrosion and give results of recent
research conducted on the corrosion and protection of metal constructions.
The corrosion of some new alloys is also considered. The collection includes
articles generalizing the results of research conducted during the last 2-3
years in the Department for Corrosion of Metals of the Moscow Institute of
Steel (Moscow Steel Institute). Some of the articles were written in
cooperation with the laboratory staffs of the "Sverdlovsk" Plant and
Khimicheskii zavod im. N.I. Malinina (Chemical Plant named Malinina) and
are based on investigations conducted at these plants. In generalities are
mentioned. There are 219 references, Soviet and non-Soviet. References
accompany each article.

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Card 3/4

AVAILABLE: Library of Congress (DMS.756)

26

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AVAILABLE: Library of Congress (DA62.F64)	

S/137/62/000/001/203/237
A154/A101

AUTHORS: Tomashov, N. D., Mil'vidskiy, M. G.

TITLE: Pickling titanium in acid solutions and alkaline melts

PERIODICAL: Referativnyy zhurnal, Metallurgiya, no. 1, 1962, 88, abstract 11622
(Sb. "Korroziya i zashchita konstrukts. metallich. materialov".
Moscow, Mashgiz, 1961, 133-150)

TEXT: The possibility of pickling Ti in alkaline melts was examined. The effect of the composition and temperature of the pickling bath was studied. Treatment in a NaOH melt at 400 - 430°C for 10 - 20 min followed by washing in hot 15% H_2SO_4 is recommended for pickling Ti. The electrode potentials of the pure and oxidized surface of Ti in alkaline melts, the emf of the circuit and the current intensity of the Me (oxidized) - melt - Me (pure) pair were studied. In the pickling of Ti in alkaline melts, the processes of purely chemical interaction between the scale and the alkali play a large part, in addition to the electrochemical processes. There are 13 references.

Authors' summary ✓

[Abstracter's note: Complete translation]

Card 1/1

S/081/61/000/022/035/076
B110/B101

AUTHORS: Mil'vidskiy, M. G., Ignatova, Z. I., Vedeneyeva, M. A.,
Titov, V. A., Kikut, V. A.

TITLE: Application of urotropine to inhibit corrosion of a steel
apparatus in ammonium chloride production

PERIODICAL: Referativnyy zhurnal. Khimiya, no. 22, 1961, 261 - 262,
abstract 22I205 (Sb. "Korroziya i zashchita konstrukts.
metallich. materialov". M., Mashgiz, 1961, 245 - 253)

TEXT: The use of 1X1849T (1Kh18N9T), X17 (Kh17), and 1X13 (1Kh13) steels
in $\text{NH}_4\text{Cl} + \text{Na}_2\text{SO}_4$ solution as satisfactory corrosion-resistant construction
materials for apparatus was shown. The corrosion rate (CR) of the examined
steels was found to be reduced to ~40% by urotropine additions $\leq 1\%$. CR
was increased by urotropine additions of 0.05%. It is suggested that
urotropine be used as mixed (cathodic - anodic) corrosion inhibitor under
the working conditions of an evaporator. [Abstracter's note: Complete
translation.]

Card 1/1

89298

S/181/61/003/001/039/042
B102/B204

24,7500 (1136, 1143, 1160)

AUTHORS: Mil'vidskiy, M. G. and Layner, L. V.

TITLE: Twins and dislocations in silicon single crystals

PERIODICAL: Fizika tverdogo tela, v. 3, no. 1, 1961, 289-296

TEXT: It was the aim of the authors to study the twin formation in the growth of silicon single crystals, and to investigate the interaction between twins and dislocations. Twins containing Si single crystals, grown in the $[111]$ and $[110]$ directions by the Chokhralskiy method were used for the purpose; the position of the twins was determined after etching in 10% NaOH at 65-80°C (20 min); the dislocation density was determined from the etch pits in longitudinal and cross sections of crystals with (111) orientation. For counting the etch pits an MMM-8M (MIM-8M) microscope was used (225x). The orientation of the specimens was determined from Laue patterns. The outward appearance of the twins is shown in Fig. 1 (a - growth axis $[111]$; b - $[110]$). The experimental results indicate that the twin boundary actually hinders dislocations

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S/181/61/003/001/039/042

B102/B204

Twins and dislocations in silicon...

from penetrating into the twinned part of the crystal; this is explained by the fact that on the twin boundary, dislocations accumulate (Fig. 4) and form a glide plane. However, it also happens that dislocations slip through this barrier (Fig. 3) as, e.g., in the case of crystals growing in the $[110]$ direction. If one assumes that an axial temperature gradient during the growth of the crystal block is the main reason of sliding, it is possible to estimate the probability of sliding in the crystal or in the twin. In this case, the entire tangential stress acting upon the glide plane $\{111\}$ may be calculated, considering the change in orientation of this plane relative to the growth axis during twinning. Table 2 gives data on the change in orientation of the (111) planes after twinning for the three main directions of growth. Calculation of the tangential stresses σ_{tan} led to the following result:

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S/181/61/003/001/039/042
B102/B204

Twins and dislocations in silicon...

Orientation of the original crystal	σ_{tan} with respect to {111} (in B)		Angle between twinning plane and pulling axis
	main crystal	twin	
[100]	3.76	2.22 1.88	0° (parallel)
[110]	1.88	2.37	54°44'
[111]	1.89	1.89 3.44	90° 19°28'

σ_{tan} is given in units of B, where $B = P/2A$, P - axial load, A - cross-section area of crystal. It could be shown that the dislocation density in the twin depends on two essential factors: a) The concentration of dislocations which penetrate the boundary toward the twin from the main crystal, and b) the orientation of the sliding system in the crystal before and after twinning with respect to the direction of the main

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89298

Twins and dislocations in silicon...

S/181/61/003/001/039/042
B102/B204

temperature gradient during the growth of the main crystal. There are 5 figures, 3 tables, and 4 references: 1 Soviet-bloc and 2 non-Soviet-bloc.

SUBMITTED: January 9, 1960

Направление роста D	Число пластинчатостей (111)	Угол пластинчатостей (111) с D	D после двойничивания	Число пластинчатостей (111) с двойником	Угол пластинчатостей (111) с D
[100]	4	35°16'	[221]	1 2 1	35°16' 11°06' 74°12'
[110]	2	0°	[110]	2 2	0° 54°44'
	2	54°44'	[411]	1 2 1	15°48' 33°00' 54°44'
[111]	1	90°	[111]	3 1	17°28' 90°00'
	3	19°28'	[511]	1 2 1	19°28' 33°45' 53°06'

Table 2

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22035

S/181/61/003/004/001/030
B102/214

9.4300 (1150, 1151, 1143)

AUTHORS: Mil'vidskiy, M. G. and Golovin, B. I.

TITLE: The form of the crystallization front of single crystals of
semiconductors bred from a melt by the method of Chokhralskiy

PERIODICAL: Fizika tverdogo tela, v. 3, no. 4, 1961, 1015-1018

TEXT: The form of the boundary between crystal and melt depends essentially on the thermal conditions on the crystallization front. Since a curvature of the crystallization front causes thermal stresses leading to increasing dislocation density and also causing a nonuniform distribution of the impurities, it is important for the preparation of semiconductor crystals to work under such conditions as ensure a plane crystallization front. Only if the crystallization front is plane, the structure will be perfect and the properties homogeneous. The most important factors affecting the form of the front are the removal of heat through the crystal and the melt, and the release of the latent heat of fusion. One of the possibilities of influencing the crystallization front in a desired manner (for example, to obtain a plane front) consists in a programming of the rate of growth of

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22035

S/181/61/003/001/030
B102/B214

✓

The form of the...

the crystal. Under simple assumptions, the rate of growth v_1 guaranteeing a plane crystallization front is given by the relation $v_1 = v \pm S/A$ (the minus sign holds for a concave front). The quantity S/A has the dimension of a velocity and can be used for the estimation of the curvature of the front: it is called the "relative front curvature" (A is the cross-sectional area of the crystal rod, S is the volume of the spherical segment melting per unit time on account of the release of the latent heat of fusion). To obtain a plane crystallization front experimentally, the authors have carried out a programming of the pulling rate. The experimental apparatus is shown schematically in Fig. 2. Silicon crystals were grown in a vacuum from a melt contained in a quartz crucible. The charge was 60-70 g, the speed of the crucible with the melt was 6 rpm, and that of the priming device 5 rpm. The form of the front was found out by two independent methods. The following results were obtained: In a crucible of 48 mm diameter, the relative front curvature is not affected by a change of the rod diameter between 13 and 28 mm. At a pulling rate of 1.2 mm/min, the crystallization front is convex; its curvature decreases with decreasing level of the melt in the crucible. On detaching the rod from the melt a plane front is obtained. The effect of the pulling rate

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S/181/61/003/004/001/030
B102/B214

The form of the...

on the front form was accurately investigated in the range of 0.07-2.6 mm/min. If the rate is changed from 0.07 to 2 mm/min, the curvature of the front will decrease; at 2.6 mm/min, the sign of the curvature will change - from convex the front becomes concave. For different levels of the melt, $v = f(S/A)$ is represented graphically. The optimum pulling rate can be determined from the obtained family of straight lines intersecting the two axes. The results agree well with the formula given at the beginning. There are 5 figures and 3 references. The most important reference to the English-language publication reads as follows: J. Wilks, Proc. Inst. Electr. Engin. 106, part B, 1959.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskooy promyshlennosti Moskva (State Scientific Research and Planning Institute for the Rare-metal Industry, Moscow)

SUBMITTED: April 12, 1960 (initially),
October 27, 1960 (after revision)

Card 3/4

189500

1418 1043 2808 1160

28070
S/181/61/003/009/002/039
B102/B104

AUTHORS: Turovskiy, B. M., and Mil'vidskiy, M. G.

TITLE: Characteristics of the growth of crystals grown in a melt by Chokhral'skiy's method

PERIODICAL: Fizika tverdogo tela, v. 3, no. 9, 1961, 2519-2524

TEXT: Periodic macrostructural properties may be observed in crystals grown by Chokhral'skiy's method. They may look like single and multiple "screw threads" or like "growth stripes". These patterns are closely correlated as to their positions. To explain their formation, the authors started by assuming an asymmetrical temperature field in the melt, i. e., a cooler zone was considered to face the observation window. The linear dimensions of "screw threads" may then be determined by the velocity of rotation, the pulling rate, and the thermal asymmetry (magnitude of zones and of temperature gradients in them). This assumption was verified by experiments. While the assumption of an asymmetrical temperature field alone is sufficient to explain the formation of single "screw threads", it is not sufficient to explain that of multiple "screw threads" nor the

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28070
S/181/61/003/009/002/039

Characteristics of the growth of crystals...B102/B104

periodic impurity distribution. An analysis of temperature field and impurity distribution in the melt and of the effect of rotation on both allowed the conclusion that the impurity distribution is determined not only by the asymmetry of the temperature field but also by the effect of a diffusion layer with increased impurity concentration. A formation of multiple "screw threads" may be explained by the specific effect of impurities in the diffusion layer upon the equilibrium temperature at which a melt of a different composition crystallizes. A crystal may be considered to grow from the melt in a continuous manner. Concentric rotational figures will then appear, and the crystal will derive a helical structure from them. The impurity concentration will differ from one spiral to another. These assumptions are backed by experimental results. There are 6 figures and 6 references: 2 Soviet and 4 non-Soviet. The three references to English-language publications read as follows: E. Billig. J. Inst. Metals, 83, 53-56, 1954-1955; W. C. Dash. Phys. Rev. 97, no. 2, 1955; W. Edwards, Canad. J. Phys. 38, 439, 1960.

Card 2/3

28070

S/181/61/003/009/002/039

Characteristics of the growth of crystals...B102/B104

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy
institut redkometallicheskey promyshlennosti Moskva (State
Design and Planning Scientific Research Institute of the
Rare Metals Industry, Moscow)

SUBMITTED: January 4, 1961

Card 3/3

TUROVSKIY, B.M.; MIL'VIDSKIY, M.G.

Simulator for stirring the melt in Czochralsky's crystal-growing method. Kristallografiia 5 no.5:759-762 S-0 '61.
(MIRA 14:10)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut
redkometallicheskooy promyshlennosti.
(Hydrodynamics) (Crystals--Growth)

189500

26648
S/070/61/006/005/006/011
E132/E560

AUTHORS: Turovskiy, B.M. and Mil'vidskiy, M.G.
TITLE: Making a model of the mixing of a melt when growing
crystals by Czochralski's method
PERIODICAL: Kristallografiya, 1961, Vol.6, No.5, pp.759-762
TEXT: The movement of liquids having different kinematic
viscosities when the crystal and the crucible are rotated has been
studied by making a model of the process. On simultaneous
rotation of the crystal and the crucible mixing proceeds because
of the action of the rotating crystal. It is suggested that the
spiral current lines formed by impurities in the melt are the
origin of spiral non-uniformities in transverse sections of the
crystal. The crystal and the crucible were rotated in opposite
directions and water, glycerine and mixtures of water, glycerine
and methyl alcohol were used to simulate the melt. The
absolute velocity of rotation of the crucible relative to its
surroundings is important because it affects the circulation of
impurities differing in density from the melt. Picking up
impurities from the bottom of the crucible begins at a definite
Card 1/2

Making a model of the mixing ...

26618
S/070/61/006/005/006/011
E132/E560

speed of rotation of the crystal and depends on the diameter of the latter, on the level of liquid in the crucible and on the kinematic viscosity when the crystal only is rotated. When the crucible is rotated stirring of the liquid is much less and impurities are not picked up. Acknowledgments are expressed to T. T. Shestakovaya and I. D. Klishin for their assistance. There are 4 figures, 1 table and 4 references; 2 Soviet and 2 non-Soviet. The English-language references read as follows:
Ref.1: A. J. Goss, R. E. Adlington. Marconi Review, 22, 132, 1959;
Ref.4: P. R. Camp. J. Appl. Phys., 25, 4, 1954.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i
proyektnyy institut redkometallicheskey
promyshlennosti
(State Scientific Research and Design Institute
for the Rare Metal Industry)

SUBMITTED: December 15, 1960

Card 2/2

MIL'VIDSKIY, M.G.

Shape of crystallization front and nature of the cross-sectional impurity distribution in single crystals grown by Czochralsky's method. Kristallografiia 6 no.5:803-804 8-0 '61.

(MIRA 14:10)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut redkometallicheskoj promyshlennosti.

(Crystals--Growth)

18.9500
24.7500

24.80
S/126/61/011/006/006/011
E073/E435

AUTHORS: Mil'vidskiy, M.G. and Layner, L.V.

TITLE: Microhardness and Dislocation Density in Silicon Single Crystals

PERIODICAL: Fizika metallov i metallovedeniye, 1961, Vol.11, No.6, pp. 923-926

TEXT. The microhardness of a crystal depends not only on individual dislocations but on the collective behaviour of larger conglomerations of such dislocations, i.e. it depends on the mutual distribution and the interaction of dislocations. Therefore, a direct correlation can be anticipated between the hardness and the density of dislocations on a given section of a crystal. The microhardness was measured on various crystallographic planes of single crystals drawn from the melt in vacuum according to the method of Czochralski. The microhardness depends on the method of preparing the surface of the specimens for measurements. After grinding, the microhardness H amounted to 1670 kg/mm². By chemical polishing in an acid mixture of HF:HNO₃ (1:2) for 2 to 3 min, the Card 1/4

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S/126/61/011/006/006/011

E073/E435

Microhardness and Dislocation ...

surface layer which was internally stressed by grinding was removed; then the microhardness was 950 kg/mm². Equal values were obtained from natural cleavages of the specimen and therefore chemical polishing can be considered as the most suitable method of preparing the specimen surface for measurements. The density of the dislocations was determined on the basis of the cavities formed during etching in the mixture HF:HNO₃:(CH₃CO)₂O(1:3:3) for 25 to 30 minutes. Simultaneously, for some specimens, the specific resistance and the lifetime of the non-basic current-carriers were determined. The dependence of the microhardness in plane (111) on the density of the dislocations in silicon single crystals is plotted in Fig.1. The increase in microhardness is particularly pronounced if the dislocation density changes within the limits of 1×10^3 to 2×10^4 cm⁻²; this results in an increase in the microhardness from 830 to 1250 kg/mm². Outside this range the microhardness changes much less. The changes in microhardness along the planes (110) and (100) are also fully in correlation with the distribution of the dislocation

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Microhardness and Dislocation S/126/61/011/006/006/011
E073/E335

densities; regardless of the crystallographic orientation, the maximum microhardness was always observed at the edges of the specimen and the minimum in its central part. Usually, sections with increased microhardness show a shorter lifetime of the minority current-carriers. It was established that a correlation exists between the microhardness and the density of dislocations in various crystallographic planes of silicon single crystals. The anisotropy in the microhardness of silicon single crystals drawn from the melt is determined by the general distribution of the dislocations along the crystal which is associated primarily with the thermal conditions pertaining during the growing of the crystal. Acknowledgments are expressed to D.B. Kiseleva for her assistance in carrying out the experiments.

There are 2 figures, 1 table and 13 references: 4 Soviet and 9 non-Soviet. The four latest English-language references quoted are: Ref. 6 - Wolf, G.A., Toman, L., Field, N.J. and Clark, J.C. Semiconductors and Phosphors, New Jersey, 1958; Ref. 10 - Dash, W. - Appl. Phys., 1959, 30, No. 4, 459;

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24480

Microhardness and Dislocation

S/126/61/011/006/006/011
E073/E335

Ref. 12 - Roberts, D., Stephens, P. and Hunt, P. Nature,
1957, 180, No. 4587, 665; Ref. 13 - Green, G., Hogarth, C.
and Johnson, F. J. Electron. and Control, 1957, 3, No. 2, 171.

ASSOCIATION: Nauchno-issledovatel'skiy i proyektnyy institut
redkometallicheskey promyshlennosti (Scientific
Research and Design Institute of the Rare Metals
Industry)

SUBMITTED: August 12, 1960

Card 4/4

24157

S/032/61/027/005/003/017
B119/B215

9.4300

AUTHORS: Mil'vidskiy. M. G. and Berkova, A. V.

TITLE: Visualization of irregularities in the distribution of
impurities in silicon single crystals

PERIODICAL: Zavodskaya laboratoriya, v. 27, no. 5, 1961, 557-559

TEXT: Irregularities in single crystals of silicon are made visible by the method of anodic etching. Electron-type and hole-type single crystals of silicon with different resistivities like those obtained from melts by the Chokhral'skiy method were used for these studies. The crystals were ground with boron carbide 220 and M-28 (M-28) powder, after which one side of the crystal was plated with nickel. That side of the crystal which was not nickel-plated was used as an anode and, therefore, dipped into the electrolyte (48% of HF:glacial acetic acid = 1:1). A platinum foil was used as a cathode. The required d-c was obtained from a BCA-5 (VSA-5) rectifier. The working conditions suited best for electron-type crystals were such: treatment at a current density of 10 milliamperes/cm² for 2-5 min and subsequent treatment for 20 to 30 sec with a 1:4 acid mixture consisting of 48% HF
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24157
S/032/61/027/005/003/017
B119/B215

Visualization of ...

and HNO_3 (58%). Optimum conditions for hole-type crystals: treatment for 4-6 min at a current density of 45 to 50 milliamperes/cm², followed by a bath in $\text{HF}:\text{HNO}_3 = 8:15$ for 10-15 sec. The acid bath was applied for separating the layer of electrolytic products deposited on the crystal surface during etching. Crystals prepared in this manner have light and dark strips alternately, which are spiral in transverse cuts, and straight and parallel in longitudinal cuts. The latter are the so-called "growth bands" which are caused by periodic fluctuations of the impurity concentrations along the rod. They characterize the shape of the crystal front at any moment of growth. There are 2 figures and 7 references: 1 Soviet-bloc and 6 non-Soviet-bloc. The four most recent references to English-language publications read as follows: 1. G. H. Schwuttke, O. A. Weinreich, and P. H. Keck. J. Electrochem. Soc. 105, No. 12, 706 (1958). 2. Oroshnik. J. Electrochem. Soc., 106, No. 4, 360 (1959). 3. P. Camp. J. Appl. Phys., 25, No. 4, 459 (1954). 4. S. I. Silverman and D. R. Benn, J. Electrochem. Soc., 105, No. 3, 170 (1958).

Card 2/3

Visualization of ...

24157
S/032/61/027/005/003/017
B119/B215

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy
institut redkometallicheskoj promyshlennosti (State
Scientific Research and Planning Institute of the Rare
Metals Industry)

X

Card 3/3

S/275/63/000/C03/009/021
A052/A126

AUTHORS: Mil'vidskiy, M.G., Vysotskaya, V.N., Frolova, L.V.

TITLE: Detection of dislocation in silicon single-crystals in chemical etching

PERIODICAL: Referativnyy zhurnal, Elektronika i yeye primeneniye, no. 3, 1963, 16, abstract 3B101 (Sb. tr. Mosk. vech. metallurg. in-ta, no. 4, 1962, 285 - 291)

TEXT: Experiments were carried out on selecting an etching agent for dislocation detection in Si single-crystals. A 3-component system of HF, HNO₃, and CH₃COOH was investigated as well as a system of the same acids, but with Br additions. The optimum relation of the acids was found to be equal to (1:3:3). If small amounts of Br (0.08 ml) are added to this system, the time of etch pit detection decreases to some degree, and if increased amounts of Br are added, the density of detected etch pits reduces greatly. It was found that the acid concentration had a great effect on the quality of etching. Optimum acid concentrations are: for HF - 50-52%, for HNO₃ - 60-62%, and for CH₃COOH - glacial concentration.

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Detection of dislocation ...

S/275/63/000/003/009/021
A052/A126

Sometimes in the process of work an oxidation of the sample was observed which was caused by the presence of excess water in the etching agent at a lowered HNO_3 concentration. To bind the water in the etching solution, acetic acid was replaced by acetic anhydride. This agent proved to be the best; it enables one to detect maximum density of etch pits and gives the most distinct picture. There are 14 references.

I.R.

[Abstracter's note: Complete translation.]

Card 2/2

S/181/62/004/010/022/063
B108/B104

247300

AUTHOR: Mil'vidskiy, M. G.

TITLE: The form of the p-n junctions in semiconducting single crystals grown by oriented crystallization from compensated melts

PERIODICAL: Fizika tverdogo tela, v. 4, no. 10, 1962, 2791 - 2794

TEXT: The p-n junctions in a semiconductor, grown from a melt with donor- and acceptor-type impurities that compensate each other, will have the shape of the front of crystallization if the latter is plane. If it is not plane the two types of impurities will not be distributed uniformly across the crystal. It is shown from various examples that the true shape of the p-n junctions does not coincide with the shape of the crystallization front since various factors influence the distribution of the compensated impurities. The major factors are the ratio of the donor to the acceptor-type impurity concentrations, any specific distribution of the impurities in the melt, and the shape of the front of crystallization. There are 4 figures. ✓B

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S/181/62/004/010/022/063
B108/B104

The form of the...

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy
institut redkometallicheskey promyshlennosti, Moskva
(State Design and Planning Scientific Research Institute
of the Rare Metals Industry, Moscow)

AB

SUBMITTED: May 21, 1962

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35075

S/032/62/028/004/007/026
B101/B113

AUTHORS: Mil'vidskiy, M. G., and Layner, L. V.

TITLE: Method of detecting dislocations in Si single crystals

PERIODICAL: Zavodskaya laboratoriya, v. 28, no. 4, 1962, 459-462

TEXT: To make dislocations in Si single crystals apparent, a 15-25 min thermal treatment of the crystals at 850-900°C in vacuo ($\sim 1 \cdot 10^{-5}$ mm Hg) and cooling at a rate of $\sim 40^\circ\text{C}/\text{min}$ is suggested. The decorating of dislocations with copper in H_2 atmosphere is even more efficient. The tests were made with n-type and p-type single crystals prepared by Chokhral'skiy's method. Before thermal treatment, the specimens were ground with boron carbide and M14 (M14) powder. After thermal treatment, they were polished in acid CP-8 (SR-8) mixture and etched in $\text{HF} : \text{HNO}_3 : (\text{CH}_3\text{CO})_2\text{O} = 1 : 3 : 3$. The pits were counted with an MVM-8M (MIM-8M) metallographic microscope. It was found that the thermal treatment did not change density and position

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S/032/62/028/004/007/026
B101/B113

Method of detecting ...

of the dislocations. The form of the etched figures observed depended on the heat treatment and on the decorating method. Dendritic inhomogeneities and stratified distribution of impurities were observed. The thermal pre-treatment increases the sensitivity of chemical etching as well as the possibility of metallographically detecting inhomogeneities. There are 5 figures and 4 references: 1 Soviet and 3 non-Soviet. The three references to English-language publications read as follows: R. A. Logan, A. J. Peters. J. Appl. Phys., 28, 2, 1419 (1957); W. Dash. J. Appl. Phys., 27, 10, 1193 (1956); W. Dash. J. Appl. Phys., 30, 459 (1959).

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy institut redko-metallicheskoj promyshlennosti (State Scientific Research Institute of the Rare Metals Industry)

Card 2/2

П/181/63/005/002/020/051
B104/B102

AUTHORS: Mil'vidskiy, M. G. and Berkova, A. V.

TITLE: Occurrence of the "face effect" in silicon single crystals grown by the Czochralski method

PERIODICAL: Fizika tverdogo tela, v. 5, no. 2, 1963, 513-517

TEXT: When single crystals are grown in the directions $\langle 111 \rangle$, $\langle 110 \rangle$, and $\langle 100 \rangle$, a $\{111\}$ plane may arise in the interface crystal-melt. Within this plane the distribution of the alloyed impurities varies. Channels enriched with impurities may form in the ingot, these occurring not only in convex or plane crystallization fronts but also in concave fronts. The development of channels in the crystal is due to undercooling. The following possibilities of undercooling when crystals are bred by the Czochralski method are discussed: (1) natural thermal undercooling at a given pulling rate; (2) constitutional undercooling due to the concentration drop before the crystallization front; (3) undercooling due to solidified particles evaporating into the melt. The tendency to form channels in Si single crystals alloyed with donor impurities decreases in

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Occurrence of the "face effect" in ...
the following order Sb, As, P. No channels were observed in Si(B, Al)
alloyed with acceptor impurities. Generally these three reasons for
undercooling are superimposed. There are 2 figures.

5/181/63/005/002/020/051
B104/B102

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy
institut redkometallicheskoj promyshlennosti, Moskva
(State Design and Planning Scientific Research Institute
of Rare Metals Industry, Moscow)

SUBMITTED: August 27, 1962

Card 2/2

Mill'vidskiy, M. G.

AID Nr. 977-10 27 May

IMPURITY SEGREGATION IN Si SINGLE CRYSTALS GROWN BY
THE CZOCHRALSKI METHOD (USSR)

Mill'vidskiy, M. G., and A. V. Berkova. Fizika tverdogo tela, v. 5,
no. 3, Mar 1963, 709-716. S/181/63/005/003/002/046

The "plane effect," the "edge effect," and anomalous impurity segregation were studied in doped Si single crystals with p- and n-type conductivity and resistivity from 0.001 to 100 ohm·cm. The single crystals were grown by the Czochralski method in vacuum or in an inert atmosphere in the [111], [110], and [100] directions, and at deviations from these directions of up to 12°. The doping agents were: P, As, Sb, Al, and B in concentrations up to 10^{16} to 10^{19} at./cm³. The "plane effect," evidenced by "canals" (i. e., spiral-shaped regions of higher impurity concentration along the growth axis), was observed in the crystals. The canals are central in crystals grown in the [111] direction but shift toward the crystal's edge in the case of disorientation of the seed. The central canal usually develops

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AID Nr. 977-10 27 May

IMPURITY SEGREGATION [Cont'd]

S/181/63/005/003/002/046

only in the presence of a convex crystallization front. Dimensions of the canal are a very sensitive function of the front curvature. Etching of the samples revealed that the canals are formed by arrowlike segments or bands which build the spirals. The periodicity of the bands corresponds to the periodicity of the "growth bands" seen in the longitudinal cross section of the crystal. The spirals in the canals are perpendicular to the $[111]$ direction and represent traces of the $[111]$ plane. Under favorable conditions, all faces in the $\{111\}$ system can appear during the growth of a single crystal. Canals were present in crystals containing P, As, and Sb donor impurities but were not observed in those with B and Al acceptor impurities. The highest intensity of the plane effect occurred for Sb, with an average increase of the segregation coefficient in the vicinity of the canal of 30 to 45%, and the lowest was found for P with an increase of 7 to 12%. The effect of growing conditions, i. e., the pulling rate and the rotation of the crucible, were studied. The intensity of the plane

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AID Nr. 977-10 27 May

IMPURITY SEGREGATION (Cont'd)

9/181/63/005/003/002/046

effect increased with increasing pulling rates, with the maximum development of the canal obtained at 2.5 mm/min. The rotation changed the shape of the canals, but did not eliminate them. The presence of canals in crystals contributed to the nonuniform distribution of structural defects in the ingot. The second effect observed was the "edge effect," i. e., a marked increase of the resistivity in an n-type Si single crystal in the direction of the near-surface zone, which is lean in impurities. The experimental results indicate that the edge effect is apparently due to preferential evaporation of the doping agent from the surface layers of the melt at the interface. This work was completed at the State Design and Planning Scientific Research Institute of the Rare Metals Industry. [EDW]

Card 3/3

Mil'vidskiy, M.G.
AID Nr. 974-2, 22 May

ELECTRON MOBILITY IN STRONGLY DOPED SILICON (USSR)

Omelyanovskiy, E. M., V. I. Fistul', and M. G. Mil'vidskiy. Fizika tverdogo tela, v. 5, no. 3, Mar 1963, 921-927. S/181/63/005/003/032/046

An experimental study has been made of the Hall mobility of electrons in n-type silicon single crystals strongly doped with arsenic and phosphorus (concentration, 10^{17} - 10^{20} cm⁻³). Measurements were conducted at temperatures from 78 to 300°K. Curves of the temperature and concentration dependence of Hall conductivity and of the concentration dependence of specific resistance were obtained. The results show an unexpected difference between the mobility versus concentration curves of samples with arsenic from those of samples with phosphorus at liquid-nitrogen temperatures, despite coincidence of these curves at room temperatures. With low temperatures and large impurity concentrations (above $7 \cdot 10^{19}$ cm⁻³), carrier mobility decreased with increased impurity concentration. The data cannot be explained by the theory of carrier scattering on impurity ions unless a strong screening effect of ions by electrons is assumed to take place at distances closer to the ions than is the case for weakly doped semiconductors.

[BB]

Card 1/1

AZD Nr. 985-4 7 June

**POLYTROPY OF IMPURITIES IN n-TYPE Ge AND Si SINGLE CRYSTALS
DOPED WITH LARGE AMOUNTS OF GROUP V ELEMENTS (USSR)**

Fistul', V. I., M. G. Mil'vidskiy, E. M. Omel'yanovskiy, and S. P. Grishina.
IN: Akademiya nauk SSSR. Doklady, v. 149, no. 5, 11 Apr 1963, 1119-1122.
S/020/63/149/005/013/018

A study carried out at the State Scientific Research Institute of the Rare Metals Industry showed that the total impurity content in n-type Ga and Si single crystals doped with large amounts of P or As (impurity content in the melt from which the crystals were grown $> 2 \cdot 10^{20} \text{ cm}^{-3}$) is higher than that which has been determined from the Hall effect. It was concluded that in this case, in contrast to Ge and Si crystals doped with small amounts of group V elements, only a portion of the impurity in the crystal is part of the substitutional solid solution, while the rest is present in other states in which the impurity does not exhibit donor properties. This phenomenon was designated "polytropy of impurities in semiconductors."

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AID Nr. 985-4 7 June

POLYTROPY OF IMPURITIES [Cont'd]

8/020/63/149/005/013/018

It is suggested and, in most instances, shown that polytropy is caused by such factors as 1) the presence of impurities in interstices; 2) the formation of a second phase of the arsenide or phosphide type; 3) the formation of cellular impurity structures; 4) the deposition of impurities on structural defects; and 5) the formation in the solid solution of such structural complexes as Si_xAs_y or Ge_xP_y . When the impurity is present in the above states, the unsaturated substitutional solid solution is thermodynamically unstable, and it is shown that an additional transfer of impurity atoms into the solid solution takes place with time. This transfer increases the carrier concentration and can be accelerated by heat treatment of the crystals in hydrogen. Further studies of the polytropy of impurities in semiconductors are urged in view of the assumption that the state of impurities in single crystals should determine the life of semiconductors doped with large amounts of impurities.

[BAO]

Card 2/2

MIL'VIDSKIY, M.G.

Disorientation and some other defects in silicon single crystals
grown by Czochralsky's method. Fiz. tver. tela 5 no.8:2102-2104
Ag '63. (MIRA 16:9)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut
redkometallicheskoj promyshlennosti, Moskva.
(Silicon crystals--Defects)

MIL'VIDSKIY, M.G.; GRISHINA, S.P.

Segregation of impurities along grain boundaries in heavily alloyed
silicon single crystals. Fiz. tver. tela 6 no.2:483-488 F '64.
(MIRA 17:2)

1. Gosudarstvennyy nauchno-issledovatel'skiy i proyektnyy institut
redkometallicheskoj promyshlennosti, Moskva.

L 20274-65 EWT(m)/EWP(w)/EWA(d)/T/EWP(t)/EWP(b) AZDC(a)/SSD/AFWL/ASD(a)-5/
ASD(p)-3/RAEM(a)/ESD(gs)/ESD(t) JD

ACCESSION NR: AP4041693

S/0181/64/006/007/1962/1966

AUTHOR: Mil'vidskiy, M. G. ; Yermeyev, V. V.

TITLE: Procedure for estimating the thermal conductivity coefficients
of solids and alloys near the melting temperature

SOURCE: Fizika tverdogo tela, v. 6, no. 7, 1964, 1962-1966

TOPIC TAGS: crystal growth rate, melt diagram, melting point, thermal conductivity, indium antimonide, germanium, silicon

ABSTRACT: In view of the considerable experimental difficulties involved in direct measurements, especially for materials which have a large chemical activity in the molten state, the authors propose for the estimate of the thermal-conductivity coefficients a method based on growing crystals of identical size at two different growth rates and measuring the temperature gradients at the phase boundaries during the course of the experiment. The validity of the method is

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ACCESSION NR: AP4041693

2
demonstrated by writing down the heat balance equations for the two growth rates. Tests for the determination of the thermal-conductivity coefficients of InSb, Ge, and Si crystals grown by the Czochralski method are described. The results confirm that the temperature gradients change noticeably with growth rate on the liquid side of the phase boundary, but remain approximately constant on the solid side. The results are compared with existing data and the conditions under which the proposed technique yields reliable results are discussed. The most important requirement is that the radiation heat loss be negligible. Orig. art. has: 2 figures, 5 formulas, and 1 table.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i proyekt-nyy institut redkometallicheskoj promyshlennosti, Moscow (State Scientific Research and Design Institute of the Rare Metals Industry)

SUBMITTED: 09Jan64

ENCL: 02

SUB CODE: SS, TD

NO. REF SOV: 006

OTHER: 005

Card 2/4

L-8707-65 EWT(1)/ENG(k)/EWT(m)/EPR/T/EWP(b) Pz-6/Ps-4 IJP(c) JD/AT

ACCESSION NR: AP4044931

S/0181/64/006/009/2762/2770

AUTHOR: Mil'vidskiy, M. G.; Fistul', V. I.; Grishina, S. P.

TITLE: Behavior of impurities in highly doped semiconductors 21

SOURCE: Fizika tverdogo tela, v. 6, no. 9, 1964, 2762-2770

TOPIC TAGS: semiconductor single crystal, highly doped semiconductor, germanium single crystal, silicon single crystal, arsenic impurity, phosphorus impurity, antimony impurity, aluminum impurity.

Impurity polytropy

ABSTRACT: The alleged polytropy of impurities, i.e., the states in which they do not display donor properties, has been studied in silicon and germanium n-type crystals doped with arsenic, phosphorus, antimony, or aluminum in concentrations greater than $5 \times 10^{17} \text{ cm}^{-3}$. The study was undertaken to explain the disagreement, previously observed in the case of high dopant concentrations, between the Hall measurements and radioactivation analysis data and the resulting violation of the known condition for ionisation equilibrium, which was verified experimentally for lower dopant concentrations. The single

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L 8707-65

ACCESSION NR: AP4044951

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crystals were grown by the Czochralski method in the $\langle 111 \rangle$ direction. The following interconnected main factors were found experimentally to be responsible for polytropy of impurities: formation

tion of a crystal. Aging or heat treatment of germanium crystals resulted in an increase of the carrier concentration and practical agreement between the Hall measurement and activation analysis data. Density of dislocations and concentration of clusters decreased at the same time. These facts are explained in terms of migration of the impurity into solid solution. In silicon crystals, the heat treatment did not produce the same effect as in germanium, since polytropy of impurities was caused mainly by the cellular sublattice which is not removed by heat treatment. It was concluded that the polytropy of impurities is closely connected with structural imperfections, even though minor, in growing single crystals and, there-

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L 8707-65

ACCESSION NR: AP4044951

fore, dependent on the conditions of crystal growth. The nature of the alloying impurity and the interaction between the atoms of the impurity and the base component of the alloy also play an important role in the appearance of polytropy, since the polytropy is dependent on the distribution coefficient of impurities. Only with base

on the distribution coefficient of impurity. Orig. art. has:
5 figures and 1 formula.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy institut
redkometallicheskey promyshlennosti, Moscow (State Scientific
Research Institute of the Rare Metals Industry)

SUBMITTED: 21Dec63 ATD PRESS: 3112 ENCL: 00
SUB CODE: 88, MM NO REF SOV: 011 OTHER: 005

Card 3/3

L 10365-65 ENT(1)/ENT(m)/EPF(c)/I/EEC(b)-2/ENP(b) Pr-4 IJP(c)/AFETR/AFWL/
ASD(a)-3/ESD(gg)/AS(mp)-2/ESD(t)/RAEM(t) JD

ACCESSION NR: AP4046645

S/0181/64/006/010/3170/3172

AUTHORS: Mil'vidskiy, M. G.; Stolyarov, O. G.; Berkova, A. V.

TITLE: Concerning the mechanical properties of heavily doped silicon single crystals

SOURCE: Fizika tverdogo tela, v. 6, no. 10, 1964, 3170-3172

TOPIC TAGS: silicon, single crystal, doping, mechanical property, impurity concentration, crystal lattice structure, dislocation free crystal

ABSTRACT: Dislocation-free single crystals grown by the Czochralski method and doped with 1×10^{15} -- 1×10^{20} cm⁻³ B, As and P, with 1×10^{15} -- 2×10^{18} cm⁻³ Al, and 1×10^{15} -- 8×10^{18} cm⁻³ Sb were investigated. The deformation was carried out at 800C (+1°) in an atmosphere of spectroscopically pure helium at the relative rate of 6.8×10^{-4} sec⁻¹. Five samples were used to determine the upper yield

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L 10365-65

ACCESSION NR: AP4046645

point for a given impurity concentration. At impurity concentrations of 10^{15} -- 10^{16} cm^{-3} all samples had the same upper yield point of ~ 20 kg/mm^2 . At higher impurity concentrations, the behavior of p- and n-type samples was quite different. The introduction of acceptor impurities strengthened the crystals while donor impurities weakened them. The yield point decreased on approach to the limit of solubility of an impurity but p-type crystals were stronger. The relatively low strength of dislocation-free single crystals and the effect of the doping impurities on the yield point were explained by the presence of vacancies and their interaction with carriers and doping impurities and by the effect of doping impurity on the silicon lattice. "The authors thank V. I. Fistul' for discussions." Orig. art. has: 2 figures.

ASSOCIATION: Gosudarstvennyy nauchno-issledovatel'skiy i projektnyy institut redkometallicheskey promyshlennosti, Moscow (State Scientific-Research and Design Institute for Rare-Metal Industry)

Card 2/3

L 10365-65

ACCESSION NR: AP4046545

SUBMITTED: 19May64

ENCL: 00

SUB CODE: SS

NR REF SOV: 007

OTHER: 002

Card 3/3

L 11998-65 EWT(m)/ENP(t)/ENP(b) IJP(c)/AFWL/ASD(s)-5/ESD(t) JD
ACCESSION NR: AP4048397 S/0181/64/006/011/3259/3262

AUTHORS: Mil'vidskiy, M. G.; Stolyarov, O. G.; Berkova, A. V.

TITLE: Dislocations in heavily doped silicon single crystals ¹⁴ ²⁷ ¹⁸ ^B

SOURCE: Fizika tverdogo tela, v. 6, no. 11, 1964, 3259-3262

TOPIC TAGS: silicon, single crystal, doping, impurity concentration, dislocation density

ABSTRACT: Single crystals doped with phosphorus, arsenic, antimony, boron and aluminum were investigated. The dopant concentration in crystals was measured by means of the Hall effect. It ranged from

crystals was measured by means of the Hall effect. It ranged from 5×10^{14} to $1.1 \times 10^{20} \text{ cm}^{-3}$ in the case of P, As, and B doping, up to $8 \times 10^{18} \text{ cm}^{-3}$ in the case of Sb, and up to $2 \times 10^{18} \text{ cm}^{-3}$ in the case of Al. The single crystals were grown by the Czochralski method along the [111] direction. No special measures were taken to prevent the development of dislocations in the ingots. The disloca-

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tion density was determined by chemical etching in a chromium reagent and decoration with copper, as well as by x-ray diffraction. Single crystals of the p-type, doped with B and Al, had dislocations (10^3 -- 10^4 cm⁻²) throughout the investigated range of impurity concentration. Single crystals of the n-type behaved differently: the dislocations disappeared at a definite concentration of the dopant.

dislocations disappeared at a definite concentration of the dopant. On doping with P and As, the dislocations disappeared (by climb to the surface) at resistivities of $\rho \sim 0.03 \text{ ohm.cm}$ ($n = 5 \times 10^{17} \text{ cm}^{-3}$). These n-type crystals remained dislocation-free over a wide range of the dopant concentrations (dislocations reappeared only on approach to the solubility limit). The results are explained as follows. The dislocation climb to the crystal surface is facilitated by a high concentration of vacancies. The vacancy concentration is affected by impurities: if the impurity concentration and the carrier density are comparable, the presence of donors should increase the vacancy concentration and the presence of acceptors should reduce it.

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The difference between the critical impurity concentrations at which dislocations disappear in crystals, observed between P and As on one side and Sb on the other, may simply be due to different atomic radii.

to S. P. Grishina for supplying the samples. Orig. ext. name: a
figures and 1 formula.

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